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THERMOVISION INSPECTION OF RUBBER HEATING IN PROCESS OF TENSION

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ABSTRACT: Thermovision camera scanning is the most commonly used method to study thermal fields of materials. From measured thermograms it is possible to obtain time dependence of temperature. This article deals with determination of temperature rise of work area. In the same time we have investigated dependence of load by elongation. From obtained elongations and temperature differences we have computed coefficient of thermal expansion of distinguished rubber blend.

KEY WORDS: passive thermography, work area of sample, rubber, coefficient of thermal expansion

1. INTRODUCTION

Infrared thermography is one of the most common techniques for non-destructive testing of materials. Theoretical background to infrared thermography can be found in [1].
Mechanical behaviour of material can be described by mechanical properties like Young's modulus, Yield strength, lose factor, ultimate strength. How the structure deforms is characterized by tensor of deformation and tensor of stress. Theoretical background to this tensors can be found in [2].
In literature [3] are listen basic informations about tests that are possible to make by Hounsfield H20K-W test machine. In the work [4] authors have evaluated rolling resistance for distinguished tyre constructions. In the work [5] authors have studied relation between tyre parameters and temperature of vulcanization. In the work [6] author have studied heat generation in different textile materials by IR camera. In the work [7] author have dealed with determination of failure properties of rubber blends.

1. THEORETICAL BACKGROUND

Infrared thermography can be divided into two approaches – *passive* thermography and *active* thermography. In passive thermography no thermal stimulus is needed to detect temperature differences. In active thermography, to detect temperature differences, is needed external temperature stimulus.

An IR camera can be used in two basic cases:

- To find the defect – place that has different temperature distribution as the surrounding places
- To measure temperature of selected area – there is problem with noise, because IR camera is proper to find temperature differences, not the temperatures.

For eliminating the noise, is useful to scan the material, before the heating process start. From thermograms average thermogram of temperature distribution can be obtained. When this thermogram is subtracted from measured thermograms, obtained new thermograms have higher ratio of signal to noise. The distribution in thermograms is then not temperature distribution, but temperature difference distribution.

Temperature distribution can be then computed with adding the temperature of begin. In most cases is the temperature distribution in material before heating uniform. Then the temperature of begin can be found as average temperature from material in first thermogram.

Engineering stress σ can be found from equation

$$\sigma = \frac{F}{A}, \tag{1}$$

where: F – load
A – characteristic area, area perpendicular to load

Characteristic area A can be computed from equation

$$A = a.L, \tag{2}$$

where: a – sample width
L – sample thickness

Strain ε, in tension test with constant speed of elongation v, can be computed from equation

$$\varepsilon = \frac{dl}{l_0} = \frac{v.t}{l_0}, \tag{3}$$

where: dl – extension of sample(in the load direction)
l_0 – original length of sample work area
v – speed of elongation

Coefficient of thermal expansion α can be computed from equation

$$\alpha = \frac{l - l_0}{l_0.\Delta T} = \frac{dl}{l_0.\Delta T} = \frac{\varepsilon}{\Delta T} \tag{4}$$

where: ε - strain
ΔT - temperature difference between temperature and temperature in begin of process.

2. EXPERIMENTAL APPARATUS

Tension test was provided by Hounsfield H20K-W test machine. More important detail to test machine can be found in [2].

3. RESULTS AND DISCUSSION

In the figure 1 is shown stress – strain curve obtained from test machine.

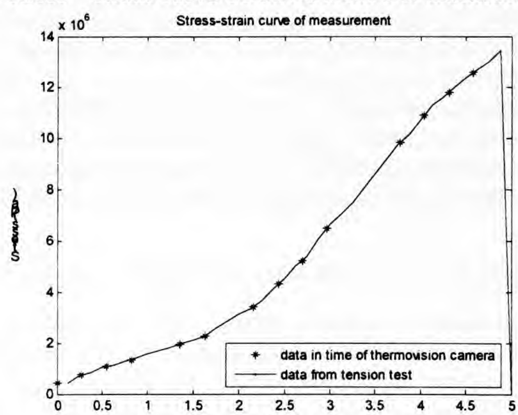

Fig.1: Stress – Strain curve obtained from measurement

In the figure 2 is shown time dependence of temperature also with linear fit.

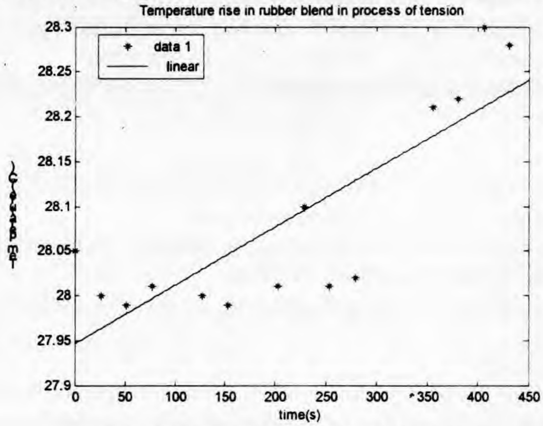

Fig.2: Time dependence of temperature

Coefficient of thermal expansion for distinguished rubber blend, according to relation (4) was found to be $\alpha = 0.00132729\ K^{-1}$.

From presented results, one can conclude, that IR camera is proper for determination of temperature rise in process of tension. Value of α is higher as for metals, what was also expected, because elongation in metals is lower as in the rubber blends and temperature rise is higher.

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